

SYNTHESIS OF NANOSTRUCTURES IN CHLORINE-CONTAINING MEDIA

Schur D.V., Dubovoy A.G.*, Zaginaichenko S.Yu., Kotko A.V.

Institute for Problems of Materials Science of NAS of Ukraine, Laboratory №67,
3 Krzhyzhanovsky str., Kyiv, 03142 Ukraine

* Fax: 38 (044) 424-0381, E-mail: shurzag@materials.kiev.ua

Introduction

Modification of carbon nanostructures by different chemical elements opens an opportunity for synthesis of materials of a new generation for different applications. Filling carbon nanotubes with one or other element will allow for conferring different mechanical, electrical, magnetic and other physical and chemical properties on the nanotubes.

This work demonstrates a possibility to produce such materials by the new proposed by authors [1-3] method for synthesis of carbon nanostructures using arc evaporation of materials in liquid medium.

The possibility to produce chlorine-filled nanostructures is illustrated by the example of synthesis in chlorine-containing media.

Experimental

Synthesis in the liquid phase has been carried out on the setup designed specially for these studies. The setup allows metal and graphite electrodes to be evaporated in the liquid medium at the temperature of medium 4 to 340 K using an electric arc. The arc temperature near a cathode may be as much as $1.2 \cdot 10^4$ at currents 200 to 300A. The product can be cooled at the rate of 10^{-9} K/c to 4K in the liquid phase.

The electronic control block is simple in operation and gives a possibility to vary and measure voltage and electric current. These changes in their turn allow the action on the conditions of the plasma-chemical process, which proceeds in the reactor, and the profound effect on the morphology and the yield of product.

All the chemical reagents used in synthesis have been subjected to preliminary purification and rectification. Graphite of MPG-7 grade has been used. Preliminary graphite rods have been annealed in vacuum. Metallic rods have been melted repeatedly in an arc furnace in argon medium of spectral purity.

The synthetic products have been investigated by scanning and transmission electron microscopy. The liquid phase has been studied by a spectrophotometer and mass spectrometry.

Variety in properties of different produced

carbon materials is conditioned by the electron structure of a carbon atom. The redistribution of electron density, the formation of electronic clouds of different modifications around the atoms, the hybridization of orbitals (sp^3 -, sp^2 -, sp -hybridization) are responsible for the existence of different crystalline allotropic phases and their modifications.

Experimental

The proposed method gives a possibility to produce the wider range of materials by varying conditions of their synthesis. This method allows the change of the chemical composition of electrodes and the medium where synthesis is carried out (Fig. 1.). The electrodes may contain or not contain carbon or consist of graphite doped with any element. The liquid phase in its turn may have different chemical compositions that affect significantly the structure and the composition of the forming nano-objects.

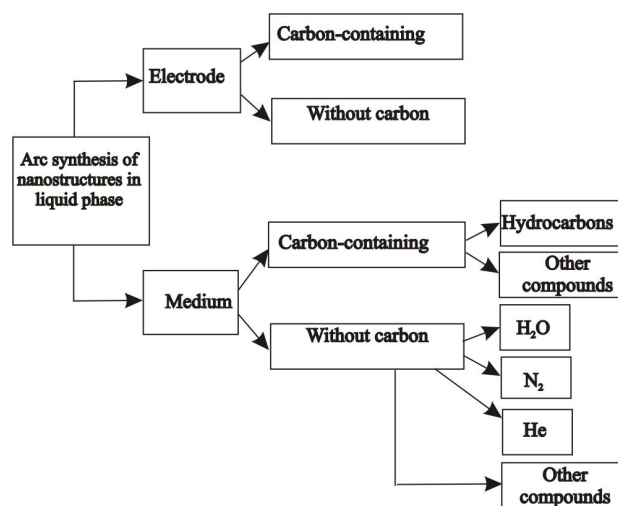


Fig. 1. Scheme for possible combinations of medium and electrode materials in synthesis of nanostructures by the arc method in the liquid phase.

In the course of arc synthesis, when carbon atoms are supplied by sufficient amounts of energy, they pass from the graphite surface into the gas phase as separate atoms or groups of atoms. In certain technological conditions they form a new carbon structure determined by

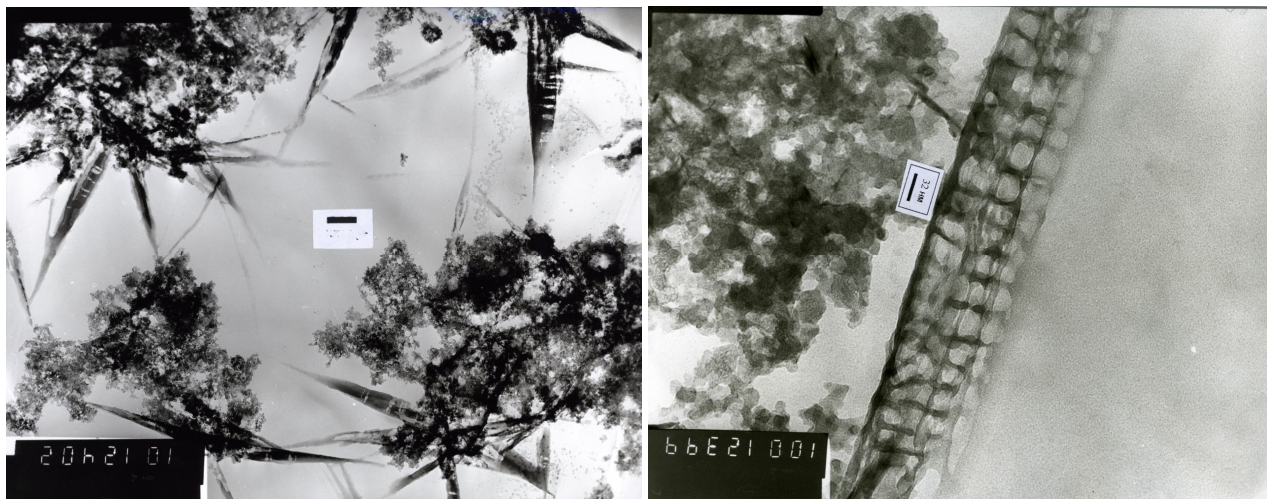


Fig. 2. Carbon nanostructures produced in CCl_4 .

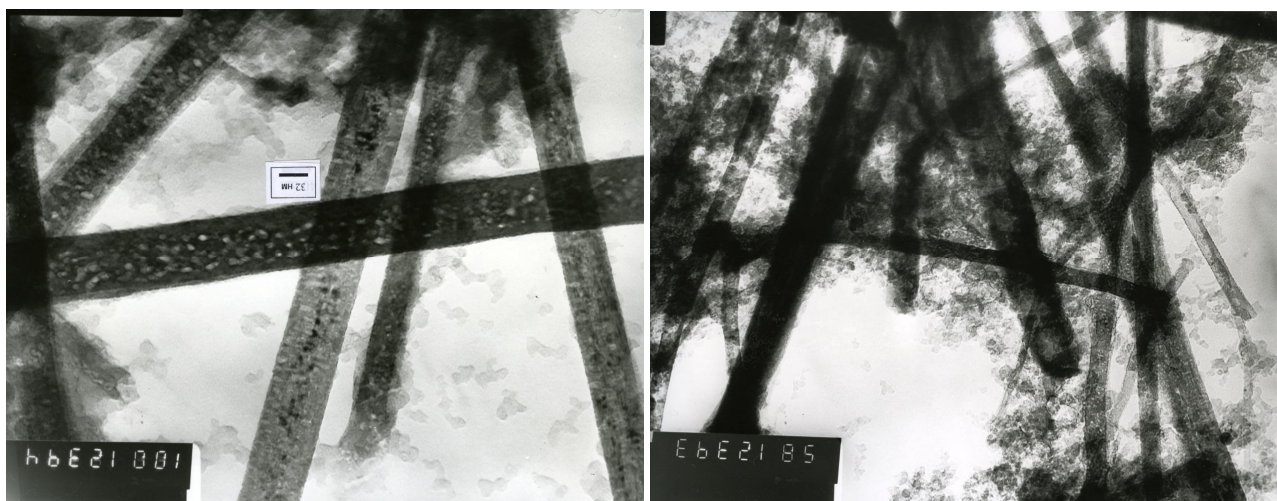


Fig. 3. Carbon nanotubes filled with a chlorine-containing compound (the tubes have been produced in dichlorethane).

synthesis conditions. As this takes place, the atoms spend the gained energy to construct this structure. The further existence of this carbon nanostructure, the conservation or the change of initial morphology and geometrical dimensions of a nucleus are determined by thermal-dynamical and technological conditions of its stay in one reaction medium or another.

During simultaneous evaporation of graphite and different elements they interact or nanostructures are doped with the element.

Fig. 2, 3 show the structures produced using CCl_4 and dichlorethane as a liquid phase.

Conclusions

The possibility to produce chlorine-filled carbon nanostructures by the arc synthesis of nanostructures in the liquid phase has been demonstrated.

The proposed method may be one of the most efficient methods for synthesis of carbon

nanostructures.

Acknowledgement

The results of the work have been obtained in the course of the fulfillment of STCU Project # 2434.

References

1. Schur D.V., Dubovoy A.G., Lysenko E.A., Golovchenko T.N., Zaginaichenko S.Yu., Savenko A.F., Adeev V.M., Kaverina S.N. Synthesis of nanotubes in the liquid phase. Extended Abstracts "Hydrogen Materials Science and Chemistry of Carbon Nanomaterials" (ICHMS'2003), 14-20 September 2003, Sudak, Ukraine, P. 399-402.
2. Schur D., Dubovoy A., Zaginaichenko S., Savenko A. Method for synthesis of carbon nanotubes in the liquid phase. Extended Abstracts "omnipress-CD" An International Conference on Carbon, Providence, USA, 11-16 July, 2004.
3. Dubovoy A.G., Schur D.V., Zaginaichenko S.Yu., Kotko A.V., Bogolepov V.A., Savenko A.F. New Carbon Structures Synthesized in Liquid Phase. Extended Abstracts "omnipress-CD" An International

Conference on Carbon, Gyeongju, Korea, 3–7 july,
2005.